REP 1996-090

# NEST MATERIAL AS A DELIVERY METHOD FOR AVICIDES: PRELIMINARY TESTS WITH AFRICAN WEAVER FINCHES

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ABSTRACT: To evaluate the potential of using nesting material as a medium for avicide delivery, five organophosphates (Dasanit®, Volaton®, fenthion, parathion, and Cyanophos®) were tested on small groups of paired male-female quelea (n = 4 to 9). Toxicants were presented to each pair of birds on five 13-cm strands of cotton string after a preliminary screening for male nest weaving behavior. Tested concentrations ranged from 100% technical grade to 0.003% compound diluted with acetone. Dasanit® was found to be the most effective candidate with some lethal effects noted at 0.012%. An optimal concentration for Dasanit® was estimated to be 0.80% based on combined male and female mortality (72%). This level was further evaluated in two aviary cage tests using 25 male-female quelea pairs during three-day exposure periods. A first replication yielded mortality ratios of 23:25 (92%) for males, but mortality ratios of only 1:24 (4%) for females. The second replication yielded mortality ratios of 24:25 (96%) for males and 11:25 (44%) for females. Females in the second group showed more weaving attempts than those in the first replication group, which could explain the pronounced mortality difference. Safety concerns about the use of toxicant-laden nesting material have not yet been evaluated in Africa. These concerns need to be addressed relative to the knowledge and literacy level of the local people applying the materials and to their awareness of methods of limiting pesticide exposures to the general public.

KEY WORDS: behavior, birds, nesting, toxicant application, avicides

Proc. 17th Vertebr. Pest Conf. (R.M. Timm & A.C. Crabb, Eds.) Published at Univ. of Calif., Davis. 1996.

## INTRODUCTION

The African weaver finch, commonly known as the Sudan dioch, black-faced dioch, or quelea (*Quelea quelea*) has a total population estimated to be in excess of several billion (Crook and Ward 1968). These birds inhabit the dry region south of the Sahara Desert and their destruction to small grain cereal crops (rice, millet, wheat and sorghum) affects the economies of 25 African nations (Schafer et al. 1973; DeGrazio and Shumake 1982). When available, quelea tend to feed mainly on small grass seeds such as *Panicum*, *Echinochloa*, *Brachiaria*, or *Setaria* that grow extensively on the alluvial plains. However, when these wild grass seeds become unavailable during the early phases of the rainy seasons, the birds cause extreme and extensive damage to cultivated cereal grain crops (Ward 1965ab).

One of the most effective control methods for depredating quelea is aerial spraying of roosts or colonies with avicides (parathion, fenthion or Cyanophos®) within the first 20 to 30 minutes after sunset (Magor 1974; Meinzinger et al. 1989). Further, it has been recommended (Ward 1972) that the control operations should be carried out only on roost and nest sites within striking distance of vulnerable crops. The main objectives of this strategy are to reduce the cost of control and to reduce pollution hazards (Magor 1974).

Aerial spraying with avicides over quelea nesting and roost colonies has been thought to kill birds either via dermal absorption, inhalation, or oral routes (Meinzinger et al. 1989). The spraying operation is considered quite hazardous to the pilot of the aircraft and to associated ground crews since it must be conducted at dusk, under dark flying conditions, and when the birds are physically present in roost or nest sites. A safer, less costly, and possibly equally effective method would involve the treatment of preferred nesting material with an avian-selective toxicant distributed by hand labor, by ground vehicles, or by aircraft over historical nesting sites prior to the breeding season. This approach to reductional control of local quelea populations could also have several other advantages over conventional aerial spraying: 1) increased safety due to less toxicant needed at lower concentrations; 2) reduced danger to pilots and ground crews; 3) lowered expenses associated with the purchase and maintenance of spray equipment; and 4) increased application potential in areas that could be treated at times during daylight hours when the birds are not physically present.

This study was conducted to evaluate the potential of using avicide-treated nesting material as a method for quelea control. Five organophosphates (Dasanit®, Volaton®, fenthion, parathion and Cyanophos®—see Appendix for chemical names) were evaluated as candidate treatments with individually caged male-female quelea pairs. (References to trade names do not imply endorsements of commercial products by the federal government.) One of the toxicants, Dasanit®, was further evaluated for efficacy with two groups of 25 male-female quelea pairs in an aviary cage.

## METHODS

Red-billed quelea were trapped in central Sudan, shipped by air to the Denver Wildlife Research Center, and held for 90 days under strict quarantine requirements in an indoor 2.4 x 4.8 x 2.1 m wire mesh aviary cage. Birds had free access to water, grit and a mixture of whole-grain sorghum, yellow millet, and Purina Game Bird Breeder Layena.

### Adaptation to Nest Material

Groups of 36 male and 36 female quelea were housed together in an indoor 2.5 x 2.4 x 2.2 m wire mesh aviary cage with mixed grain, water, grit, roosting branches (Russian olive), and nest materials (short lengths of cotton string and ribbon strips) constantly available. Throughout this 30-day adaptation period, a 12:12 light-to-dark cycle was maintained with room lights on at 0700 and off at 1900 MST. After adaptation, 18 male-female pairs were randomly selected and housed separately in 53 x 25 x 39 cm wire mesh cages for evaluations with avicide-treated nest material.

### Candidate Avicides

Five candidate organophosphate chemicals, previously registered as insecticides or avicides, were selected for assessment with male-female quelea pairs in individual cages. Parathion and fenthion were chosen because both have been used routinely for quelea roost and nest area application with aerial spray control operations for many years. Cyanophos® has also been tested experimentally with the aerial spray application method for control of quelea. The other two candidates, Dasanit® and Volaton®, are registered as insecticides and were selected for their high toxicity to finches and sparrows with relatively low toxicity to mammals.

### Avicide Assessments in Individual Cage Tests

After weaving behavior had been observed and recorded in each male-female quelea pair over a two to three week control period, the toxicant-treated material was prepared with five 13-cm strands of cotton string. This treated nest material was first introduced at full strength to 4 to 6 quelea pairs for a period of 2 hr of exposure. Bird pairs were observed repeatedly over the next 1-, 2-, 4-, and 24-hr periods and ten days post-exposure for signs of affectation (e.g., ataxia, tremors, etc.) and/or death. Serial dilutions of the toxicant concentration on the nest material were accomplished using acetone as the diluent at levels extending from 50.0% to 0.003%. Up to ten levels were evaluated for mortality effects for the candidate avicides. The avicide treatment that produced the highest number of deaths at levels below 3.23% was selected in terms of safety and cost considerations for further testing in a large aviary cage environment. For all candidate toxicants tested, closed circuit television (CCTV) observations were made to monitor and video record attempts toward male-female nest construction, passing of materials between the pairs, and total string contact time for individual quelea. Clean up of cages for toxic residues between each test consisted of using an ammonium hydroxide solution spray treatment followed by steam cleaning and water rinsing.

### Avicide Assessment in Colony Tests

Based on results from the individual cage tests, Dasanit® was selected as the candidate to receive colony tests at a concentration of 0.8% in acetone. Two replications of the colony test over an interval separated by four months were conducted. Both replications involved identical procedural sequences.

For each replicated test, 25 male and 25 female quelea were first housed together for two weeks of adaptation to the aviary cage environment and to the nest material (13-cm strands of cotton string and ribbon). Daily CCTV observations and videotapes were made during this period to document normal weaving activity with untreated nest material. Treatment consisted of saturating 250 13-cm strands of string in a 0.8% Dasanit®/acetone solution and allowing 24 hr drying time under a fume hood in a separate room before offering the air-dried material to the 50 birds on the test day. Respiratory masks to filter and capture organic vapors were used in preparation of the materials to protect research personnel. Nest material was placed in a 26.6 x 16.5 x 5.1 cm glass holder and placed on a shelf 1.3 m above the aviary cage floor. A second day of treatment exposure consisted of offering 125 strands of the material (prepared 24 hr earlier) to the remaining survivor birds. The third day of treatment was a repetition of this procedure, but only 50 strands of freshly-treated nest material were made available to the surviving birds.

CCTV videotapes were made of quelea weaving attempts and any rejection or repellency to toxic nest material was noted. The times for quelea affectation due to toxicant contact were noted for the 2 hr period during which treated nest material was introduced on each test day. All surviving birds were held for two weeks post exposure with all treated material removed from the aviary after the third exposure day. The birds were observed during this interval for delayed mortality and for chronic toxicity effects.

## RESULTS

### Avicide Assessments in Individual Cage Tests

Several concentration levels were evaluated for mortality effects with Volaton®, Cyanophos®, and Dasanit®; whereas fenthion and parathion were only evaluated at 1 to 3 levels, none below 0.78%. For the latter two compounds (Table 1), male and female combined quelea mortality ratios never exceeded 3:12 (25%) even at the 100.0% concentration level. We observed no deaths with parathion.

For tests with paired quelea using Cyanophos® (Table 2), mortality ratios ranged from 0:8 to 5:8 (0.0 to 62.5%), with the 50% concentration level producing the highest number of combined male and female deaths. With Volaton® (Table 3), an even lower level of efficacy was noted. Only one male in five tested pairs apparently succumbed to the effects of this insecticide treatment at the 33.0% concentration level.

Lethal effects of Dasanit®, in contrast to the four other candidate avicides, were observed down to 0.012% concentration in acetone solution when applied to the string-nest material (Table 4). The highest level of male (8:9), female (5:9), and combined (13:18 or 72.2%) mortality was observed with this compound at the 0.787% wt/wt concentration. This level (approximately 0.8%) was subsequently chosen for further evaluations in the colony-aviary tests. Dasanit® produced some observable effects (uncoordinated perch stance) within 25 min after introduction to caged pairs at a 3.23% concentration level representing approximately 3.5 mg Dasanit® per strand of string. At the chosen level (0.8%), total Dasanit® available to male and female quelea in each cage was calculated to be 0.36 mg or .073 mg per strand of string.

Table 1. Acute toxicity test with individually caged male-female pairs of quelea and nest material treated with fenthion or parathion.

| Concentration in Acetone (%) | Dilution Ratio | Mortality Ratios | | |
|---|---|---|---|---|
| | | Male | Female | Male + Female |
| Fenthion | | | | |
| 100.00 | 1:0 | 1:6 | 2:6 | 3:12 |
| 3.23 | 1:31 | 3:9 | 0:9 | 3:18 |
| 0.787 | 1:127 | 1:9 | 0:9 | 1:18 |
| Parathion | | | | |
| 3.23 | 1:31 | 0:6 | 0:6 | 0:12 |

Table 2. Acute toxicity test with individually caged male-female pairs of quelea and nest material treated with Cyanophos®.

| Concentration in Acetone (%) | Dilution Ratio | Mortality Ratios | | |
|---|---|---|---|---|
| | | Male | Female | Male + Female |
| 50.00 | 1:1 | 3:4 | 2:4 | 5:8 |
| 33.00 | 1:2 | 3:4 | 1:4 | 4:8 |
| 12.50 | 1:8 | 0:4 | 0:4 | 0:8 |
| 3.23 | 1:31 | 0:4 | 2:4 | 2:8 |
| 0.787 | 1:127 | 0:4 | 0:4 | 0:8 |
| 0.049 | 1:2,040 | 0:4 | 0:4 | 0:8 |

Table 3. Acute toxicity test with individually caged male-female pairs of quelea and nest material treated with Volaton®.

| Concentration in Acetone (%) | Dilution Ratio | Mortality Ratios | | |
|---|---|---|---|---|
| | | Male | Female | Male + Female |
| 50.00 | 1:1 | 0:5 | 0:5 | 0:10 |
| 33.00 | 1:2 | 1:5 | 0:5 | 1:10 |
| 12.50 | 1:8 | 0:4 | 0:4 | 0:8 |
| 3.23 | 1:31 | 0:4 | 0:4 | 0:8 |
| 0.787 | 1:127 | 0:6 | 0:12 | 0:12 |
| 0.049 | 1:2,040 | 0:6 | 0:12 | 0:12 |
| 0.003 | 1:32,640 | 0:6 | 0:12 | 0:12 |

Table 4. Acute toxicity test with individually caged male-female pairs of quelea and nest material treated with Dasanit®.

| Concentration in Acetone (%) | Dilution Ratio | Mortality Ratios | | |
|---|---|---|---|---|
| | | Male | Female | Male + Female |
| 100.00 | 1:0 | 5:6 | 2:6 | 7:12 |
| 3.23 | 1:31 | 6:9 | 3:9 | 9:18 |
| 1.27 | 1:79 | 7:9 | 3:9 | 10:18 |
| 0.787 | 1:127 | 8:9 | 5:9 | 13:18 |
| 0.392 | 1:255 | 4:9 | 1:9 | 8:18 |
| 0.196 | 1:510 | 6:9 | 2:9 | 7:18 |
| 0.049 | 1:2,040 | 7:9 | 0:9 | 7:18 |
| 0.025 | 1:4,080 | 4:7 | 0:7 | 4:14 |
| 0.012 | 1:8,160 | 2:9 | 1:9 | 3:18 |
| 0.003 | 1:32,640 | 0:7 | 0:7 | 0:14 |

Avicide Assessments in Colony Tests

The first aviary test with 25 male-female quelea pairs indicated a predominance of male mortality; this was expected, as males were the primary nest builders in the laboratory cages as is the case in the wild. As shown in Table 5, a total of 24 males and only 1 female were killed by the nest material treatment (92% and 4%, respectively). Most of the deaths (n = 18) resulted within 20 min after initial nest material contacts and weaving behavior by male birds on the first exposure day.

CCTV observations on this initial test day indicated that the male quelea were taking the introduced Dasanit®-treated nest material within 2 min after introduction. There appeared to be no detectable initial repellency at the O.8% concentration. Within 10 min of introduction of the material, the male quelea appeared to be very active and excited with much wing fluttering and "tugs-of-war" over the string. Individual quelea took whole "bales" of string in their beaks to nest sites. These behaviors were commonly observed during the control-adaptation period as new untreated nest material was introduced each day. During the colony tests with Dasanit®, however, some birds appeared uncoordinated and unable to stay perched on the tree branches within 20 min of their initial contact with treated nest material. Within 30 to 50 min, several males fell from their nest site perches on the Russian olive tree branches to the floor of the aviary cage.

On the second test day, there was less vigorous-aggressive weaving behavior by the seven remaining males. However, this may have indicated either that the best nest weavers had been killed on the previous day, or that the Dasanit treatment produced repellency or aversion. During the final third day of exposure to freshly treated nest material by remaining birds (as observed with CCTV), three females contacted the string but only very briefly. Since only one of these females died, this may indicate that bill and/or foot contact for a few seconds is necessary before a lethal dose is delivered to quelea via nest material. This was also an indication that Dasanit® vapor inhalation at the concentration and exposure interval used in the colony test was insufficient to produce any deaths or observable signs of toxicosis.

The second aviary test, conducted four months later in early February, produced similar results in male quelea (total of 24 deaths after three days of exposure), but a substantial increase in deaths of female quelea was observed (total of 11 deaths after three days of exposure). Whether the females in this second group were consistently more inclined to take nest material and to attempt to weave, or whether an increase in this weaving behavior was due to a seasonal effect, was not determined. With the indoor controlled lighting and heating regime, however, such seasonal effects were probably minimal.

CCTV observations of weaving behavior on the first exposure day of the second aviary test indicated again that several "tugs-of-war" over single strands of Dasanit®-treated string revealed no signs of initial repellency in the males. There was some head shaking and bill wiping behavior by a few males within 18 to 20 min after initial string contact. Within 30 min, males fell from their nest weaving sites to the floor of the aviary cage. A total of eight males were observed falling from the branches within the next 15 min interval post exposure.

On the second exposure day, with only one physically active male surviving, there was almost no weaving activity observed. Females were observed only tugging at the nest material already woven in place at nest sites on branches within the aviary cage. Some of the treated material may have been placed in the nest sites previously by males, but this could not be verified by CCTV observation. The third exposure day revealed only one female pecking at the string material, but she did not pick up any nest material in her bill.

Table 5. Cumulative daily and percentage total mortality in two groups of 25 male-female quelea pairs exposed for three days to 0.8% Dasanit® on nest material in colony tests.

| Exposure Day | Male | Female | Total |
|---|---|---|---|
| Cumulative Mortality (Test 1) | | | |
| 1 | 18 | 1 | 19 |
| 2 | 22 | 1 | 23 |
| 3 | 23 | 1 | 24 |
| Total (%) | 92 | 4 | 48 |
| Cumulative Mortality (Test 2) | | | |
| 1 | 24 | 8 | 32 |
| 2 | 24 | 9 | 33 |
| 3 | 24 | 11 | 35 |
| Total (%) | 96 | 44 | 70 |

## DISCUSSION

Feasibility of producing a high level of efficacy (92 to 96%) with an organophosphate insecticide (Dasanit®), using nest material as a delivery medium, was demonstrated under aviary conditions with captive male quelea. Although efficacy for the females was greatly lessened and was more variable (4 to 44%), the absence of males would undoubtedly lead to extreme reproductive failures during the breeding season. This is projected because males are the builders for almost all of the nests; and even if they became polygamous, females are not attracted to an individual male until he has constructed a viable nest, with pair-bonding then occurring after a short courtship period (Collias and Collias 1970). This reproductive failure, in turn, would lead to reduced crop losses by newly fledged birds in regions having historical quelea nesting sites within striking range.

For actual field application of this method, field efficacy data would, of course, be needed. If this method is verified as effective under field conditions, then nest material could be distributed by hand, from ground crews in vehicles, or from aircraft. For aerial application, automatic equipment has been developed (Schoenleber et al. 1973) to cut selected lengths and to distribute lure-toxicant treated twine for the control of certain insects. Automatic preparation and handling could enhance safety to applicators in terms of less dermal and inhalation exposure to the avicide. There would also be enhanced safety to the overall control operation as pilots and ground crews would no longer be limited to spray operations over the 20 to 30 min dusk period immediately following sunset (Meinzinger et al. 1989); this period provides for pilot visibility but reduces the number of quelea flushed from roost and nesting areas. Toxic nest material could be applied during those hours of daylight when birds are not in their nesting areas. Spray drift and bird-contact-spray-droplet intercept angle would not be determining factors for efficacy as is the case with spray applications.

This nest material method for applying avicide would most likely be used in addition to, rather than replacing, the aerial spraying control method. New safety concerns would have to be addressed including: assessing the environmental fate of Dasanit®, scaling-up procedures with large amounts of avicide and distributed nest material, training of control applicators, warning communications to locals, and purchasing and maintaining protective safety equipment.

Dead and dying quelea have been recovered after toxic spray applications by locals in many African countries as a supplemental source of food (Jaeger and Elliot 1989). The residue levels in quelea killed by the toxic nest material method have not been determined, but they would probably be considerably lower than those generally found with the aerial spray method. Even though quelea meat harvest is routinely discouraged, many people will probably continue to partake of the cooked birds since the practice has been going on continually for decades. Cooking the collected birds in hot water probably quickly reduces the organophosphate residues to negligible levels. No documented severe sub-lethal toxicosis or deaths have been recorded in association with this practice (Jaeger and Elliot 1989).

## ACKNOWLEDGMENTS

The authors thank Stanley E. Gaddis for technical assistance and Charles P. Breidenstein for experimental design and statistical advice. Lynn A. Fiedler and Craig A. Ramey provided helpful suggestions on revisions of early drafts of the manuscript. Supported in part with funding by the U.S. Agency for International Development USAID): PASA ID/TAB-473-1-67.

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## APPENDIX

| Trade/Common Name | Chemical Name |
|---|---|
| Dasanit® | — 0,0-diethyl 0-p-(methylsulfinyl) phenylphosphorothioate |
| Volaton® | — a-[[(diethoxyphosphinothioyl)oxy]imino]-benzeneacetonitrile |
| fenthion | — 0,0-dimethyl 0-[4-(methylthio)-m-tolyl] phosphorothioate |
| parathion | — 0,0-diethyl 0-p6-nitrophenyl phosphorothioate |
| Cyanophos® | — 0,0-dimethyl 0-[4 cyanophenyl] thionophosphate |